INDOOR AIR QUALITY ASSESSMENT

Nashoba Regional High School
12 Green Road
Bolton, Massachusetts 01701

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
July 2006

Background/Introduction

At the request of building occupants, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the Nashoba Regional High School (NRHS), 12 Green Road, Bolton, Massachusetts. Complaints of poor airflow, exacerbation of asthma, general indoor air quality concerns and potential mold related to a burst pipe that occurred over the winter of 2005, prompted the request. On April 12 and 13, 2006 the building was visited, by Cory Holmes, an Environmental Analyst for CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, to conduct an assessment. Mr. Holmes was accompanied by Jim Chiaravalloti, Head Custodian and William Spratt, Facilities Director, for portions of the assessment.

The NRHS was originally built in 1961 and was renovated in the mid 1970s. The most recent renovation occurred in 2000, which included new construction as well as renovations of interior components such as the mechanical heating and ventilation systems.

As described by Mr. Spratt and Mr. Chiaravalloti, a frozen pipe in the HVAC penthouse flooded eight rooms on the second floor and six rooms on the first floor of the NRHS in January of 2005. The pipes froze due to uncontrolled outside air entering the HVAC penthouse through a large passive vent. This vent was subsequently sealed by NRHS staff (Pictures 1 and 2). A professional flooding and restoration firm, ServiceMaster, Inc., was contacted to conduct remediation. Water damaged materials were reportedly removed or dried using heated fans and dehumidifiers. Surfaces were cleaned, disinfected and vacuumed using high efficiency particulate arrestance (HEPA) equipped vacuum cleaners.

The Nashoba Regional School District's insurance provider also retained the services of Environmental Enterprises & Associates, Inc. (EEI) to perform mold testing after remediation efforts were completed. EEI concluded that remedial actions were successful in preventing mold growth in that no elevated levels of mold spores were detected in any of the classrooms affected by the water damage (EEI, 2005).

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were conducted with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth. Moisture content of porous building materials (e.g., ceiling tiles, plaster), were measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The school houses high school students grades 9-12 with a student population of approximately 900 and a staff of approximately 100. Tests were taken during normal operations at the school and results appear in Tables 1 and 2.

Discussion

Ventilation

On April 12, 2006 carbon dioxide levels were above 800 parts per million (ppm) parts of air in ten of forty-eight areas surveyed. Carbon dioxide levels were above 800 ppm parts of air in of eight of thirty-seven areas on April 13, 2006. Air sampling indicated adequate ventilation in the majority of areas surveyed during the assessment. Please note that on both days of the assessment several classrooms had open windows and/or were sparsely populated, which can greatly reduce carbon dioxide levels.

Mechanical ventilation is provided by air-handling units (AHUs) located in the attic (Pictures 3 and 4). Fresh air is drawn through two sets of pleated air filters (Pictures 5 and 6) and continuously distributed via ducted air diffusers located in vertical columns along the perimeter of classrooms (Picture 7). Air is ducted back to AHUs via ceiling or wall-mounted return vents (Pictures 8). Several air diffusers were obstructed by stored materials impeding airflow. Several science labs are equipped with additional local exhaust ventilation that can be activated to aid in the removal of odors/particulates during experiments.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment, but should have occurred during renovations in 2000.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Temperature measurements ranged from 68^{o} F to 79^{o} F, on April 12 and from 68^{o} F to 74^{o} F on April 13, 2006, which were within or close to the MDPH recommended comfort range on both days of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 23 to 33 percent on April 12, which was below the MDPH recommended comfort range. On April 13, relative humidity measured in the building ranged from 41 to 55 percent which was within the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously mentioned, several occupants expressed lingering concerns of mold growth in ceiling panels in relation to the flooding event which occurred during January of 2005. In order for building materials to support mold growth, a source of moisture is necessary, in this case the source of moisture was a frozen pipe. Identification and elimination of water moistening building materials is necessary to control mold growth. Building materials with increased moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of the location of materials with increased moisture levels can also provide clues concerning the source of water supporting mold growth.

In an effort to ascertain moisture content of building materials in affected classrooms moisture readings were taken in areas that were the most impacted by exposure to moisture (i.e., affected classrooms). As indicated, moisture content was measured with a Delmhorst Moisture Detector equipped with a Delmhorst Standard Probe. The Delmhorst probe is equipped with three lights that function as visual aids that indicate moisture level. Readings that activate the green light indicate a sufficiently dry or low moisture level, those that activate the yellow light indicate borderline conditions and those that activate the red light indicate elevated moisture content. No elevated moisture readings were measured during the assessment (Table 1). However, several areas had water-damaged ceiling panels (Picture 9 and 10), which should be routinely replaced after a water leak is discovered and repaired.

Several moldy books and associated odors were also observed in storeroom 206-A (Picture 11), which is an interior room with no ventilation. CEH staff recommended discarding the moldy items.

A number of classrooms also had plants. Moistened plant soil and drip pans can be a source of mold growth. Plants should be equipped with drip pans; the lack of drip pans can lead to water pooling and mold growth on windowsills. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Several rooms contained aquariums and terrariums. Aquariums and terrariums should be properly maintained to prevent bacterial growth, mold growth and nuisance odors.

Other IAQ Evaluations

Several other conditions that can also affect indoor air quality were noted during the assessment. Chemical prep rooms were examined. Strong chemical odors were detected upon opening the acid storage locker in the prep room between rooms 107 and 109. Several bottles of chemicals were found sealed with rubber corks, parafilm or were capped loosely, which lead to the crystallization of materials on the surface of bottles (Pictures 12-16). These materials contain volatile organic compounds (VOCs), which can be irritating to the eyes, nose and throat. In addition, the local exhaust vent for this area was not operating (Picture 17). Chemical prep rooms are designed with local exhaust ventilation, to depressurize the prep area thus preventing odors from migrating to adjacent areas. Although local exhaust vents in other prep rooms were operating, occupants had concerns regarding the efficiency of the vents. According to Mr. Spratt, the date of the last preventative maintenance done on this equipment was unknown.

The occupant in science room 169 had complaints of airborne dust and particulates during soil labs. This room does not have additional local exhaust ventilation, however the adjacent room (171) does. CEH staff recommended examining the feasibility of extending the exhaust vent for 171 to classroom 169. Mr. Spratt recommended the possibility of conducting soil labs in room 171 as needed.

In some classrooms and in the shop areas, items were observed on windowsills, tabletops, counters, bookcases and desks (Picture 18). The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

Wood shop odors were detected in the cafeteria and other adjacent areas. Windows, interior and exterior doors were all found open in the wood shop (Picture 19) during the assessment. The assessment occurred during a breezy day, which *pressurized* the shop forcing odors into the hallway. Once in the hallway odors and particulate matter can migrate to adjacent areas (e.g., the cafeteria) where they can be drawn into the mechanical ventilation system and be distributed to other areas of the building (Picture 20).

A few classrooms had missing/dislodged ceiling tiles/panels. The movement or damage to ceiling tiles/panels can release accumulated dirt, dust and particulates that accumulate in the ceiling plenum into occupied areas. A number of exhaust and return vents had accumulated dust. If return vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles.

A portable air purifier was in use in storeroom 206-A (Picture 21). This equipment has air filters that should be cleaned or changed as per the manufacturer's instructions to avoid the reaerosolization of dusts and particulates. The filter in the air purifier was examined and found to be saturated with dust and debris. In addition the pre-filter light was "on" (Picture 22) indicating that it needed to be changed.

Finally a concern was raised in the art rooms regarding possible exposure to silica dust during pottery activities, mainly during the mixing of clay. The art room contains a local exhaust hood (Picture 23), which should be used to mix clay to draw particulates *away* from the user. Art staff should also examine the possibility of using wet, pre-mixed clay or clays that are low in silica. Exposure can also occur during cleaning of clay dust, which should be conducted using wet wiping techniques and/or the use of a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner.

Conclusions/Recommendations

At the time of the MDPH assessment, remediation of water damaged materials had been completed, which prevented the occurrence of mold growth. In view of the findings at the time of the visit, the following recommendations are made:

1. Continue to operate both supply and exhaust ventilation continuously during periods of school occupancy to maximize air exchange. Consult the school's heating, ventilation and air conditioning (HVAC) engineer concerning an increase in the introduction of outside air in areas indicated in Tables 1 and 2.
2. Contact an HVAC engineering firm to inspect and ensure local exhaust ventilation for prep rooms is operating as per specifications and develop a preventative maintenance program for this equipment.
3. Remove obstructions from supply vents (Picture 24).
4. Consider having the ventilation system balanced by an HVAC engineer every five years (SMACNA, 1994).
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters.

Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

6. Remove/replace water damaged ceiling panels. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

7. Inspect and discard mold-contaminated books, boxes and other porous items in storeroom 206-A.

8. Clean/maintain aquariums/terrariums to prevent mold/bacterial growth and associated odors.

9. Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.

10. Replace missing ceiling tiles, to prevent the egress of dirt, dust and particulate matter into classrooms.

11. Store flammable materials in flameproof cabinets in a manner consistent with state and local fire codes.

12. Have a chemical inventory done in all storage areas and classrooms. Properly store flammable materials in a manner consistent with the local fire code. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Label chemical containers with the chemical name of its contents. Follow proper procedures for storing and securing hazardous materials.

13. Consider providing local exhaust to reduce airborne dust and particulates in room 169 or coordinate with adjacent classroom to schedule labs in room 171.

14. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

16. Periodically exhaust/return vents of accumulated dust.

17. Clean/change filters for portable air purifiers as per the manufacturer's instructions or more frequently if needed.

18. To reduce/avoid potential exposure to airborne silica, conduct mixing of clay in local exhaust hood, use wet, pre-mixed clay or clays known to be low in free-silica content. If not feasible, consider discontinuing pottery program. Use wet cutting/cleaning techniques and/or HEPA filtered vacuum cleaners to reduce airborne dust.

19. Consider adopting the US EPA (2000b) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html.

20. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm.

References

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BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

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OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

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SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1

Exterior View of Large Passive Vent for HVAC Penthouse

Picture 2

Interior View of Passive Vent Sealed With Insulation Material

Picture 3

Attic Where AHUs are Located

Picture 4

AHU Located in Attic

Picture 5

Bank of Pleated Air Filters in AHU

Picture 6

2nd Bank of Pleated Air Filters in AHU

Picture 7

Column Shaped Air Diffusers

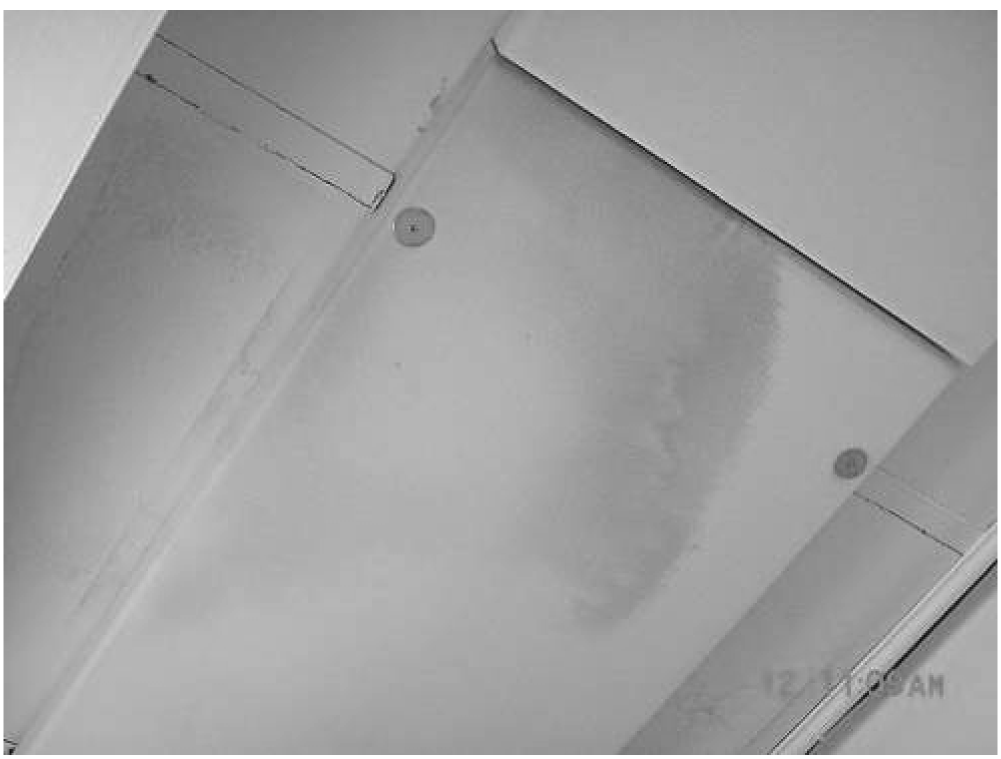
Picture 8

Ceiling-Mounted Return/Exhaust Grill

Picture 9

Water Damaged Ceiling Panels

Picture 10



Water Damaged Ceiling Panels

Picture 11

Mold Colonized Books in Storeroom 206A

Picture 12

Crystallized Materials on outside of Bottles Indicating Leaking/Off-Gassing of Materials

Picture 13

Crystallized Materials on outside of Bottles Indicating Leaking/Off-Gassing of Materials

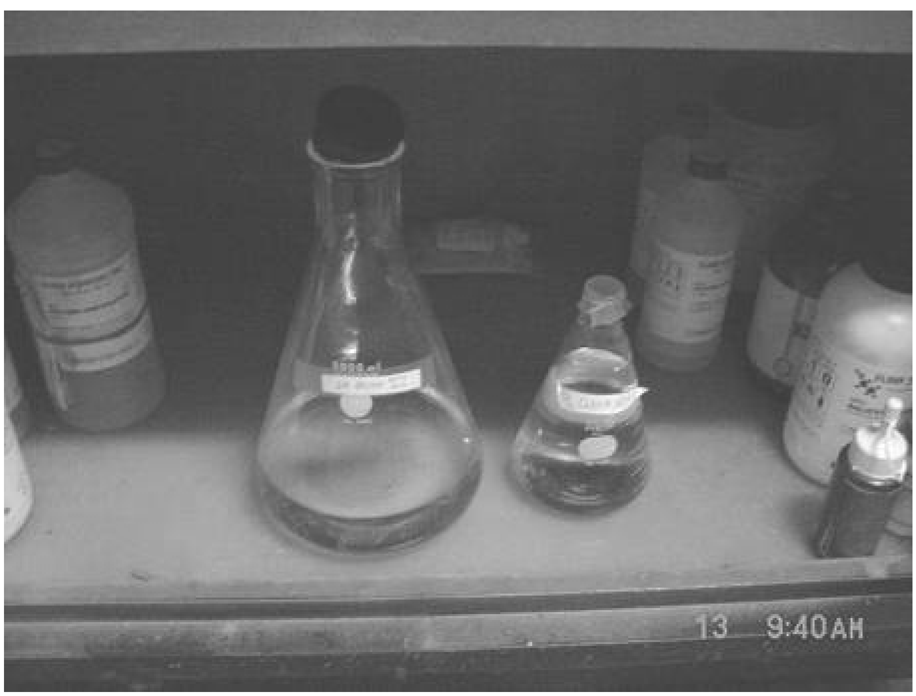
Picture 14

Unlabeled Beaker Sealed With Parafilm

Picture 15

Beakers on Rolling Cart Sealed with Parafilm, Note Beaker Hanging off Edge

Picture 16



Beakers Sealed with Rubber Stoppers, Note Crystallization on Lip of Beaker on Left Indicating Off-Gassing of Materials

Picture 17

Non-Functioning Local Exhaust Vent and Wall Switch in Prep Room (near 107)

Picture 18

Accumulated Items in the Metal Shop

Picture 19

Exterior Door to Wood Shop Propped Open

Picture 20

Open Exterior Door to Woodshop and Open Interior Door Connecting Shop Hallway to Cafeteria

Picture 21

Portable Air Purifying Unit in Storeroom 206-A

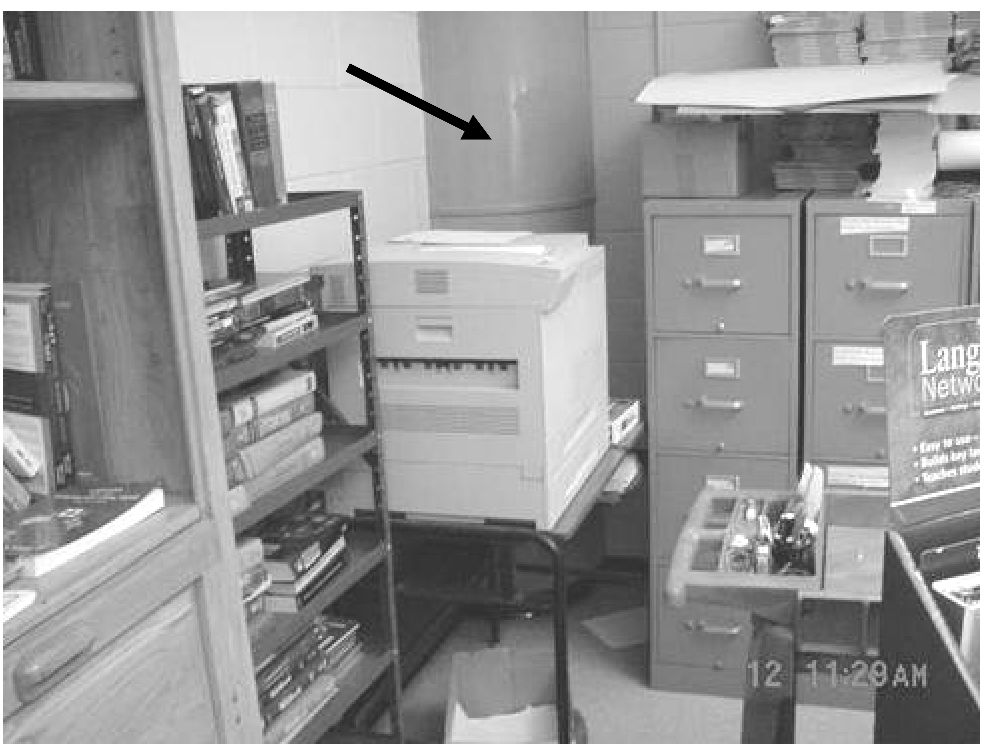
Picture 22

Close-up of Portable Air Purifying Unit in Storeroom 206-A, Indicator lights

Picture 23

Local Exhaust Hood in Art/Pottery Room

Picture 24



Items Obstructing Airflow from Vent in Vertical Column

TABLE 1

Indoor Air Test Results – Lynnfield High School, Lynnfield, MA – December 11, 2006

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	396	52	98					Light rain
234	688	68	31	4	Y	Y	Y	Exhaust-off, DO
235	586	70	29	9	Y	Y	Y	Exhaust-off, DO
233	649	70	28	14	Y	Y	Y	DEM, DO
Music Room	612	69	26	0	N	Y	Y	
253 A	660	68	26	1	N	Y	Y	DO
254 E	521	70	27	0	N	Y	Y	
Art	554	70	26	1	Y	Y	Y	Return grill on univent-detached, occupants gone 50 mins.
230	669	70	26	3	Y	Y	Y	
223	3418	71	39	17	Y	Y	Y	Univent and exhaust-off

*** ppm = parts per million parts of air, CT = water damaged ceiling tile**
PF = personal fan, DO = door open, DEM = dry erase materials
MT = missing tile

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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						Supply	Exhaust	
225	1171	72	29	9	Y	Y	Y	Exhaust-off
228	3498	68	39	21	Y	Y	Y	Univent-off/obstructed by items on top, exhaust-off, DEM
229	1357	72	31	7	Y	Y	Y	DEM
311	1710	71	32	21	Y	Y	Y	DEM, DO
312	2108	73	33	21	Y	Y	Y	Univent/exhaust-off, DEM
309	1642	74	32	15	Y	Y	Y	Exhaust-off, DEM
310 A	1421	73	28	4	Y	N	Y	Plants
306	853	72	28	2	Y	Y	N	
304	560	70	26	0	Y	Y	Y	DEM, MT
301	897	73	27	1	N	Y	Y	Heat issues reported, photocopier, passive exhaust vent

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						Supply	Exhaust	
Auditorium	510	72	27	20	N	Y	Y	
Cafeteria	767	72	28	75	Y	Y	Y	
TV Studio	674	73	27	2	N	Y	Y	
Custodian Closet					N	N	Y	Holes in AHU (Loft) “mounting template”, local exhaust-off
Media Center (circ. desk)	599	70	27	1	N	Y	Y	
Media Center (lower level)	612	67	26	10	Y	Y	Y	
Midia Center (workroom)	605	68	27	0	N	Y	N	Laminator
Teacher’s Room	729	68	29	8	Y	Y	Y	Dusty exhaust vent
Nurse/Clinic	620	70	31	4	Y	Y	Y	
Gym	546	71	29	0	N	Y	Y	

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						Supply	Exhaust	
Atheltic Storage	438	68	26	0	N	N	Y	Stagnant air/musty odors-sports equipment, mechanical ventilation-off
Coaches Office	501	70	29	0	N	Y	Y	Mechanical ventilation-off, dry trap-occasional odors reported
Girl's Locker Room	471	71	28	0	N	Y	Y	Mechanical ventilation-off
					N	Y	Y	
					Y	Y	Y	
					Y	Y	Y	
					N	Y	Y	
					N	Y	Y	
					Y	Y	Y	
					N	Y	Y	

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						Supply	Exhaust	
253	589	74	29	0	N	Y	Y	DEM, DO
254	585	73	27	0	N	Y	Y	DO
Media circulation desk	550	74	28	1	N	Y	Y	
273 computer lab	591	76	28	24	Y	Y	Y	
Media center South	500	75	27	4	Y	Y	Y	
Media center North	499	75	27	0	Y	Y	Y	
272	463	74	27	0	Y	Y	Y	
279	490	76	27	0	N	Y	Y	
Network room	422	79	26	0	N	Y	Y	2 CT
275	532	77	27	1	N	Y	Y	2 CT

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TABLE 2

Indoor Air Test Results – Nashoba Regional High School, Bolton, MA – April 13 2006

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	376	52	90					Cloudy, scattered showers, winds SW 15 mph
113 lab	581	69	55	23	Y	Y	Y	6 CT, DO, plants, DEM
111 lab	580	68	54	18	Y	Y	Y	DO, DEM, 2 aquariums, supply vent sealed (plastic & duct tape)
109	572	68	49	0	Y	Y	Y	DEM
107	606	69	50	14	Y	Y	Y	DEM, DO
Prep room	660	69	49	2	N	Y	Y	Local exhaust not operating, passive door vent
103	549	69	50	1	Y	Y	Y	26 occupants gone 5 mins., plants, DEM, dusty vents, DO
104	1050	70	51	18	Y	Y	Y	DEM
101	670	70	50	22	Y	Y	Y	DO, DEM
102	413	70	48	0	Y	Y	Y	DEM, plants
105 math office	573	68	48	0	Y	Y	Y	Open utility holes

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Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
167	424	70	46	25	Y	Y	Y	6 CT along exterior wall, local exhaust vent
167 prep room					N	N	Y	Door undercut
169	700	71	44	20	N	Y	Y	Plants, dust complaints-from soil used in labs
166	717	72	44	19	Y	Y	Y	MT, 2 CT, plants
172 lab	789	71	46	24	Y	Y	Y	DO, 7 CT along ext wall,
171	560	71	45	16	Y	Y	Y	Local ex vent, DO, DEM
171 prep					N	Y	Y	Beaker on rolling cart-hanging over edge
151	489	72	45	1	N	Y	Y	23 occupants gone 15 mins, plants, 2 CT
164	850	72	47	20	Y	Y	Y	DEM
165	460	71	45	1	Y	Y	Y	16 occ gone 25 mins, 1 CT, plants
163	696	70	45	0	Y	Y	Y	16 occ at lunch, 6 CT along ext wall, DEM

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						Supply	Exhaust	
159	679	70	46	12	Y	Y	Y	8 CT along ext wall, DEM
160 art	587	70	47	17	N	Y	Y	DEM
161 art	449	70	49	0	Y	Y	Y	Kiln vented but directly under general ex vent
158 art	524	70	47	10	Y	Y	Y	Local ex on, DO, plants, MT (corner)
162	591	70	49	21	Y	Y	Y	DO, DEM
Main office	774	71	46	5	Y	Y	Y	
404 D	606	73	42	0	Y	Y	Y	Plant, air diffuser missing
404 B	614	73	41	6	N	Y	Y	DO
404 E	892	73	42	2	Y	Y	Y	DO
404 F	780	73	42	0	Y	Y	Y	DO
404 G	824	73	42	0	Y	Y	Y	

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	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Nashoba Regional High School, Bolton, MA – April 13 2006

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Guidance	824	73	41	7	Y	Y	Y	1 CT around vent
Nurse (rear)	641	72	43	2	Y	Y	Y	Window open
Nurse (back office)	663	72	44	2	N	Y	Y	
Nurse (main area)	706	72	44	3	N	Y	Y	
406	1087	73	44	6	Y	Y	Y	DEM
422	840	73	44	1	N	Y	Y	1 MT
403 A	920	74	45	3	N	Y	Y	DO, DEM, stuffy

*** ppm = parts per million parts of air, CT = water damaged ceiling tile**
PF = personal fan, DO = door open, DEM = dry erase materials
MT = missing tile

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%